

# Classification of Stream Sensitivity: A Framework for Monitoring, Assessment and Diagnosis\*



Region 3: The Mid-Atlantic Region

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\* Funded by US EPA Regional Environmental Assessment Program (R-EMAP) and Regional Applied Research Program (RARE)



A watershed classification approach, based on differences in sensitivity of streams to nonpoint-source stressors, has been developed and applied in three pilot projects within the Great Lakes Basin and eastern U.S. First, the natural and anthropogenic watershed characteristics that control the stability of flow regimes are determined. Thresholds of change for these characteristics are identified, that, once exceeded, can induce rapid changes in hydrology, pollutant loadings, degradation of instream habitat, and biological impairment. In the most comprehensive pilot, a watershed classification framework was developed for the entire state of West Virginia, based on thresholds related to land-use and indicators of water storage in the landscape. The watershed classes were used as strata in a probabilistic survey design to assess water quality, habitat, and fish community condition of all Wadeable streams draining 12-digit HUCs. This process can readily be applied to other states and regions. Hydrologic thresholds already have been derived for homogeneous flood regions within all coastal and Great Lake states.

## How can States, Regions, and Tribes use a probabilistic sampling design both to assess condition with known confidence and to efficiently identify impaired waters?

Classification based on watershed characteristics can be used to differentiate between streams with low versus high sensitivity to nonpoint source stressors. Probabilistic sampling can be combined with watershed classification in survey designs by using either stratification or unequal probability weighting by watershed class. This combined approach allows managers to describe not only regional condition of streams, but also the probability of impairment for different classes of systems. Results can be used to help intensify further sampling within classes having high probabilities of impairment. Watershed characteristics associated with high sensitivity or high probabilities of impairment can also suggest priorities for watershed restoration or conservation measures.

## What data and information are needed in order to apply this approach?

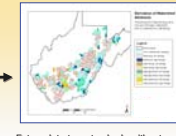
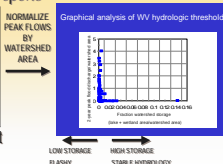
- Long-term USGS gaging station data
- Watershed characteristics
  - Catchment area
  - Main channel slope
  - Watershed storage (percent coverage of lakes + wetlands)
  - Land-use
  - Climatic variables
- Derivation of hydrologic thresholds from watershed characteristics and peak flow statistics
- Derivation of other land-use based thresholds from literature or simulation modeling



## How can we identify watersheds with different sensitivities to nonpoint source stressors using existing information?

### 1) USGS Flood frequency estimation reports

USGS Gaging Station	2-year peak flow, Q2 (cfs)	Watershed area	Main channel slope	Storage (lake + wetland watershed area)
100403690	10	2	0.02	0.02
401066890	25	3	0.03	0.05
368905420	100	4.5	0.02	0.10



### 2) Literature review of land-use impact thresholds

## How can states and tribes incorporate watersheds into a probabilistic sampling design?

### Fixed set of watershed boundaries

- National Watershed Boundary Database
- State watershed boundaries
- Automated derivation



### Association of watershed characteristics with all stream segments

- Flow-accumulated variables associated with synthetic streamlines

### Background information

Detenbeck et al. 2004b (in press)  
US EPA Aquatic Resource Monitoring (ARM) web site

## What other applications are there for watershed and water body classification?

Watershed and water body classification could aid in criteria development by identifying water bodies with different sensitivities to nonpoint source pollutants.

## How can this approach be applied in your region?

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More background information:

See list of references below and sign up for copies of reprints and reports.

## Where has this approach been used successfully?

### Lake Superior watersheds

- wadeable streams
- 2 ecological units

### Lake Michigan

- Coastal watersheds
- Riverine coastal wetlands

### West Virginia

- wadeable streams
- 3 ecoregions

## How can this approach be expanded to cover other types of surface waters?

Coastal wetlands and estuaries – Watershed hydrologic regime can affect the level of nutrients and productivity in coastal Great Lakes wetlands given similar land-use settings. However, hydrologic regime affects not only loadings from the watershed but also retention time of the receiving water. Great Lakes coastal wetlands downstream of watersheds with stable hydrologic regimes can actually have lower thresholds for nutrient effects because of their greater retention time. For estuaries, not only watershed hydrologic regime but also flushing related to tidal volume must be considered. We are currently developing a coastal classification scheme for estuarine systems in the U.S.

Lakes – Nonpoint source loadings are often correlated with high flows. Thus, within similar land-use settings, watersheds with flashy hydrologic regimes should produce higher loadings to downstream lakes than those with stable hydrologic regimes. However, if lake retention time is low enough, systems may start to behave more like coastal wetlands.